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F16D 3/205

(52) UK CL (Edition L)
F2U U536 U541

(56) Documents cited
GB 2188701 A GB 2070195 A US 4741723 A

(58) Field of search
UK CL (Edition K) F2U
INT CL[5] F16D

(54) **Tripode universal joints**

(57) A torque transmitting universal joint of the tripode type, having an outer joint part (13) with three circumferentially spaced recesses (14) extending parallel to its rotational axis and each defining opposed tracks, an inner joint member (11) having arms (12) extending into the recesses, each arm supporting a respective roller assembly (16) with a roller (18), the roller being carried relative to the arm so that it is movable lengthwise of the arm and is able to rotate about and pivot relative to the arm. Each roller is supported on a part-spherical surface of the arm or of the roller-carrying means so arranged that when the joint is transmitting torque in the aligned condition, the resultant of forces acting on the roller through the part-spherical surfaces is at a perpendicular distance from the axis of rotation of the joint different from the perpendicular distance from the axis of rotation of the joint of the resultant of forces acting on the roller from the outer joint member, so that the roller is subject to a tilting moment about its region of contact with the loaded track.

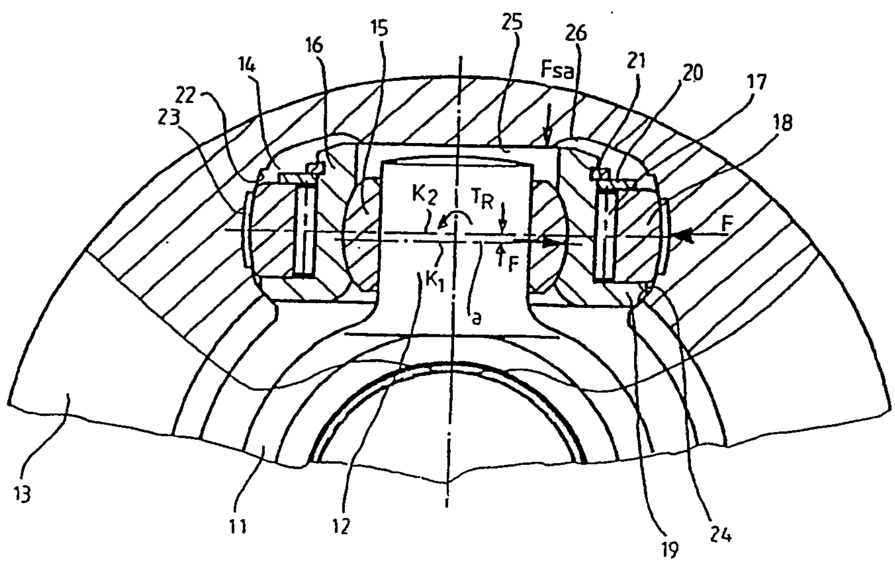


FIG 4

GB 2 259 557 A

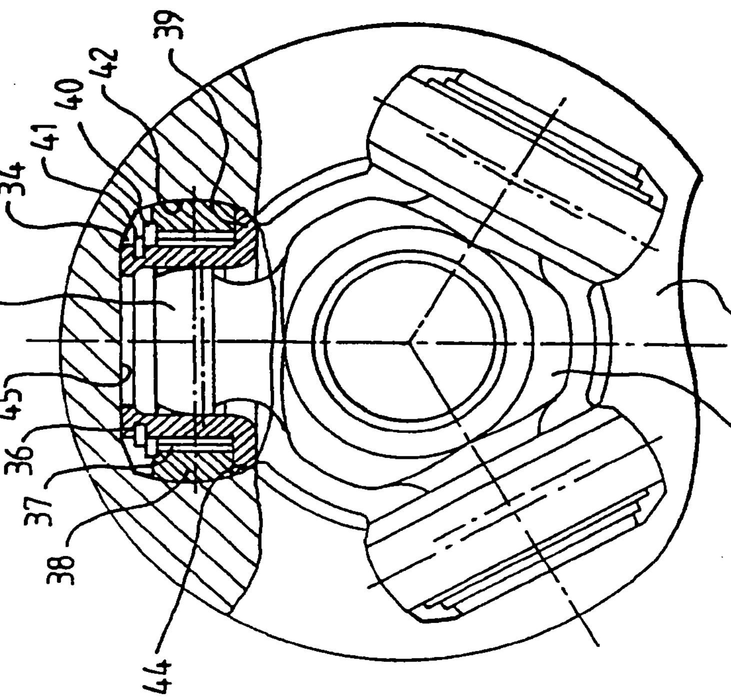
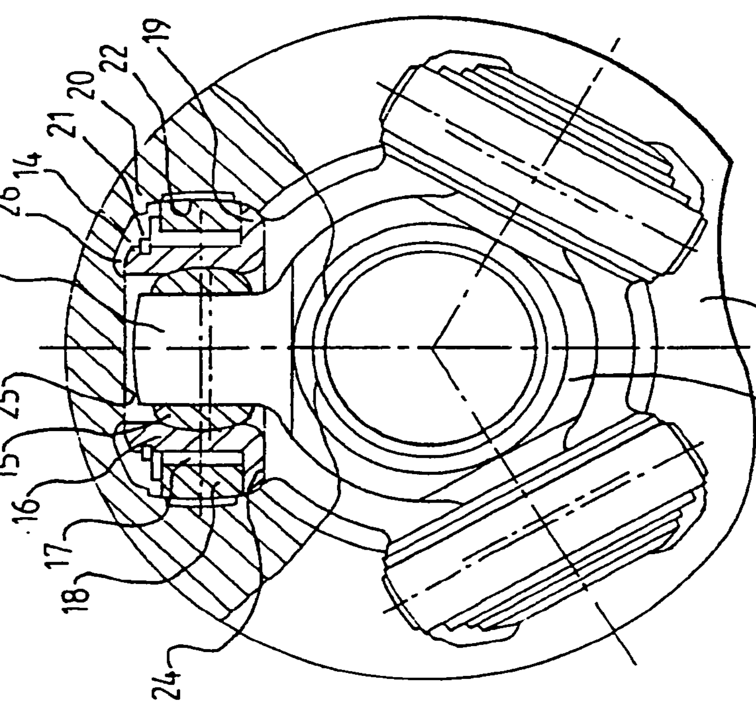

39
42
40
41
34
32
45
36
37
38
44
33
31

FIG 2


19
22
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21
14
26
12
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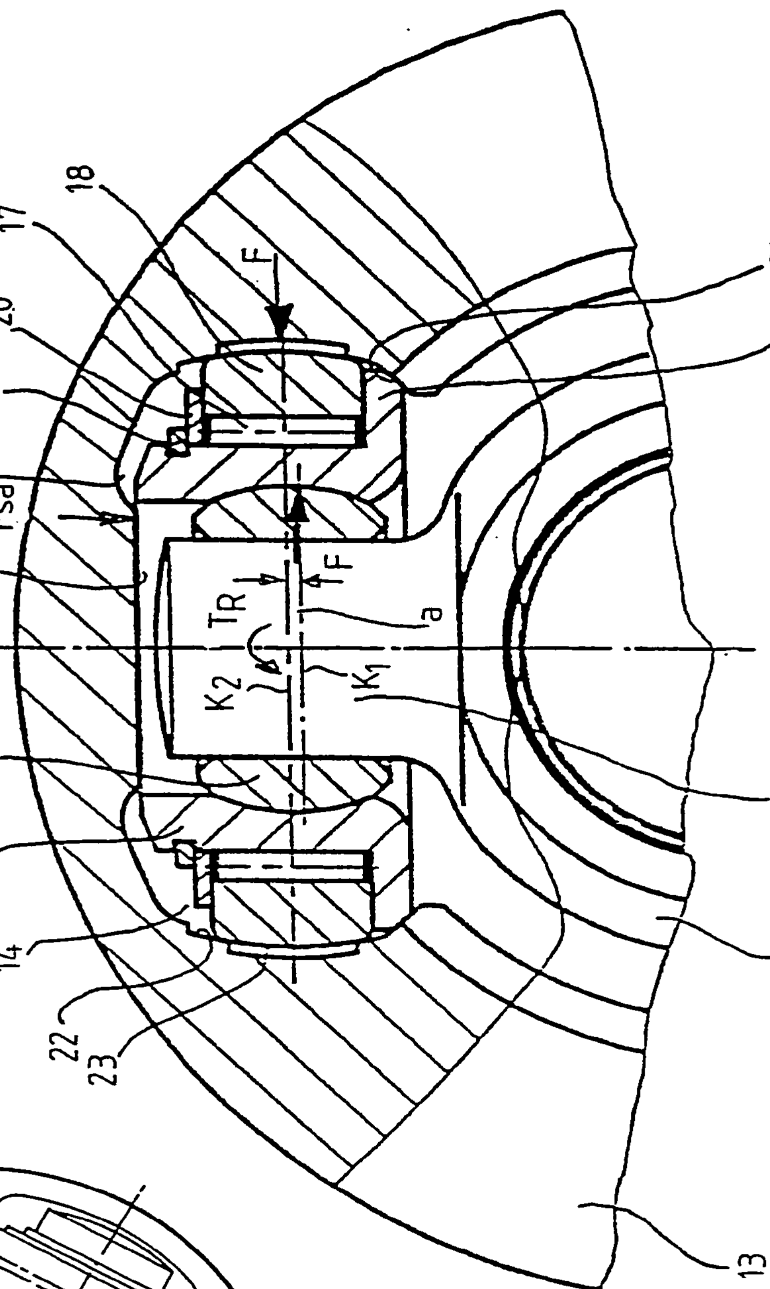
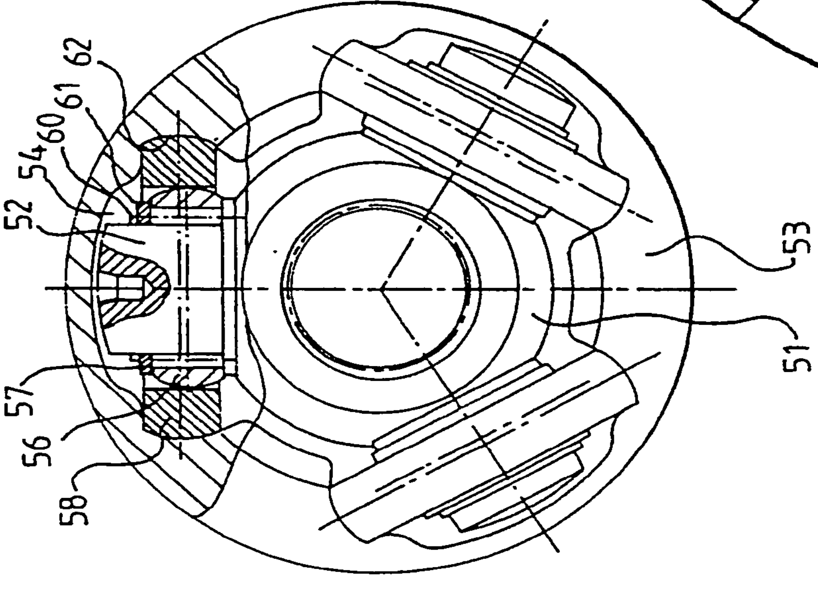
15
16
17
18
24
13
11

FIG 1



17
18
20
21
26
Fsa
25
15
16
14
22
23
24
19
F
TR
F
a
K2
K1
12
11
13

FIG 4



52
54
60
61
62
57
56
58
53
51

FIG 3

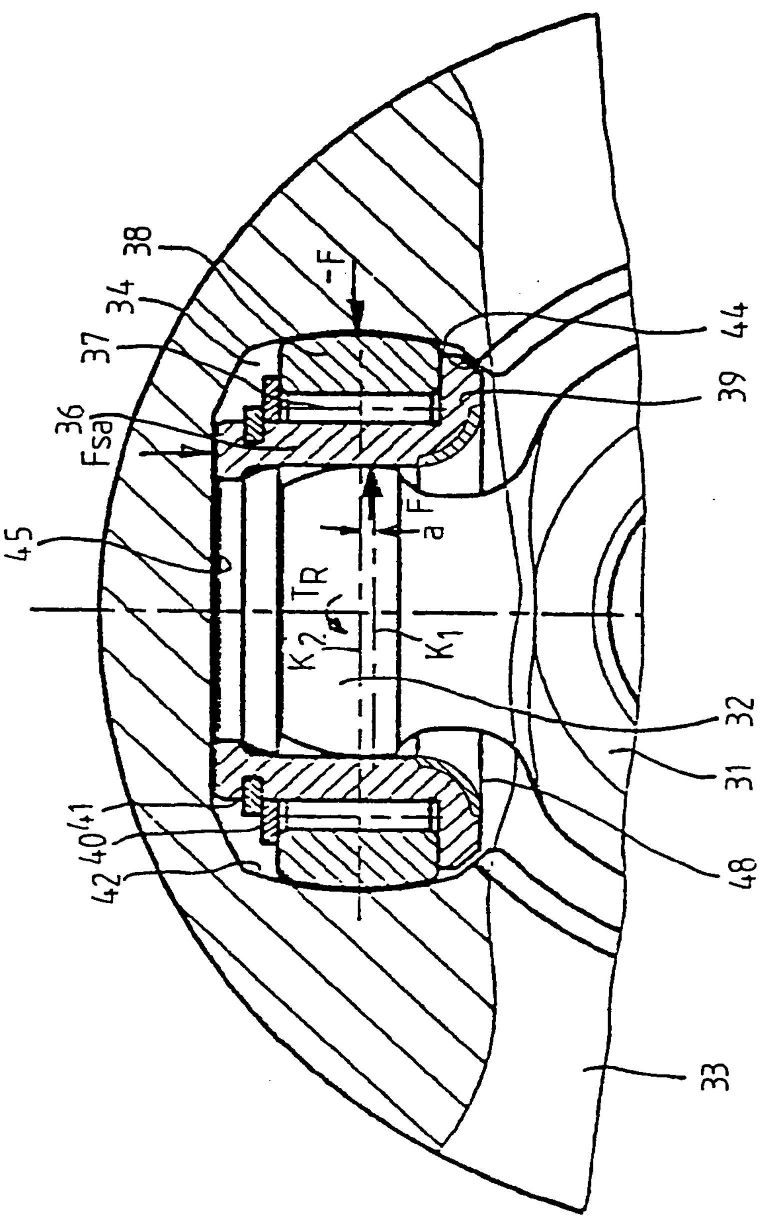


FIG 5

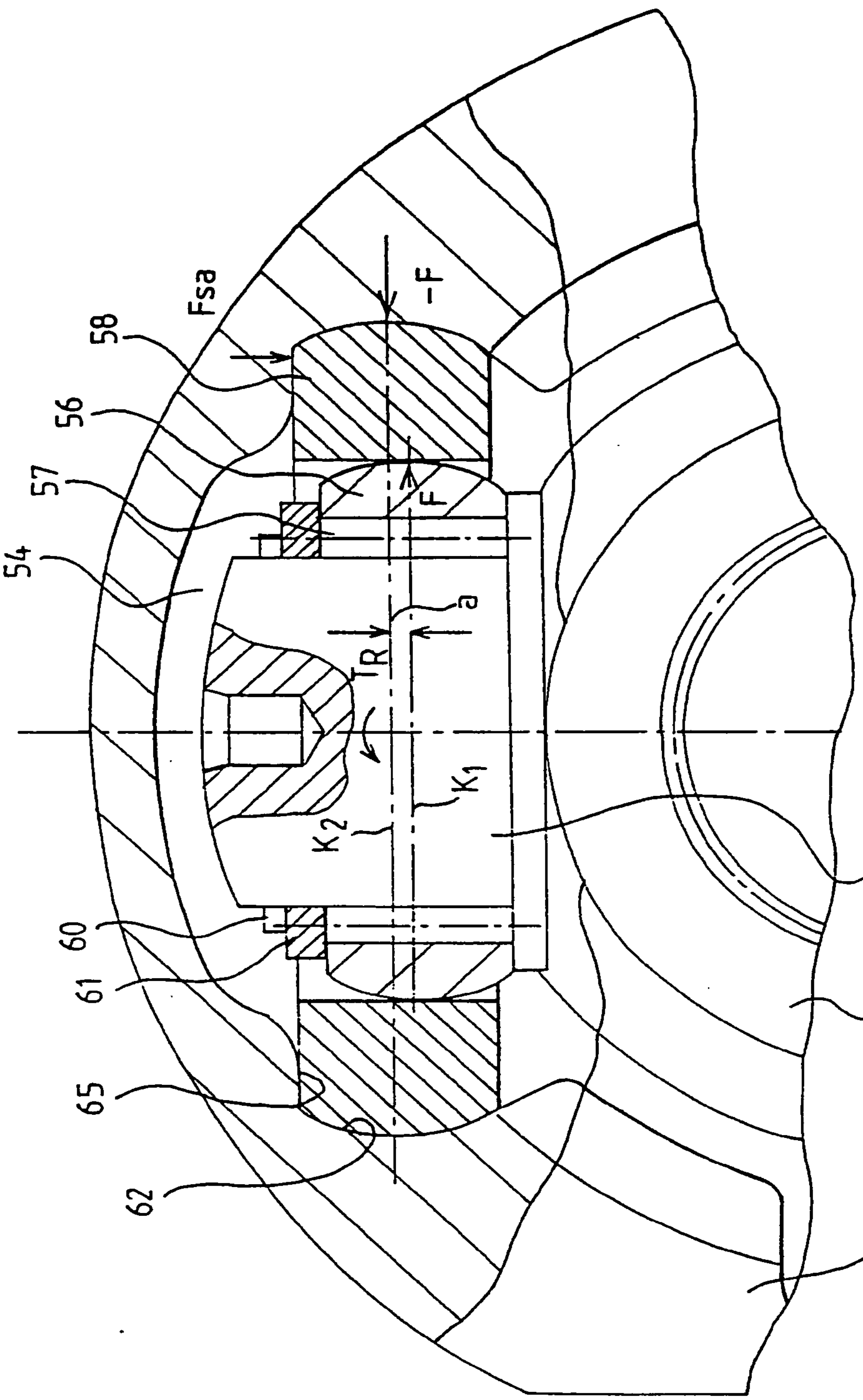


FIG 6

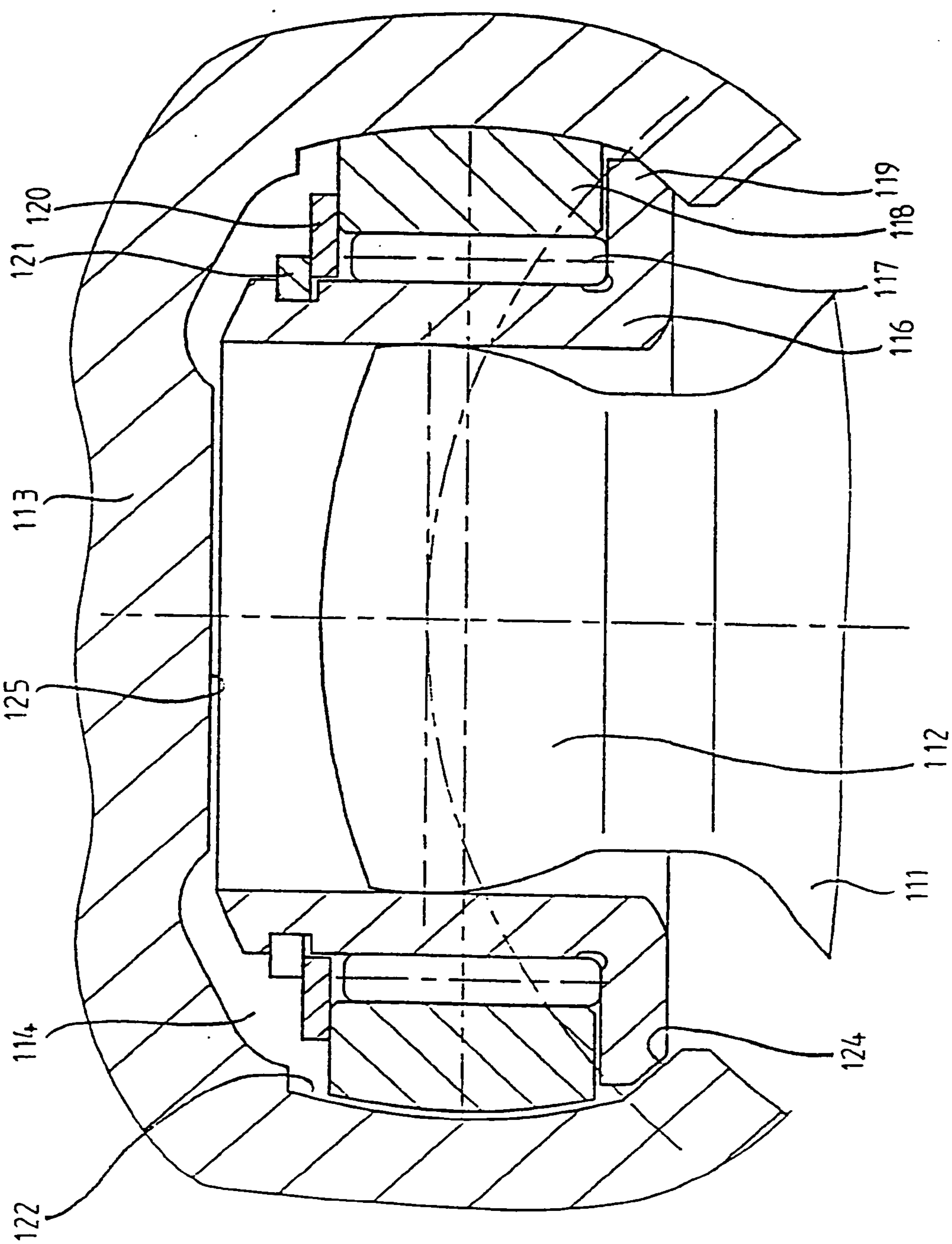


FIG 7a

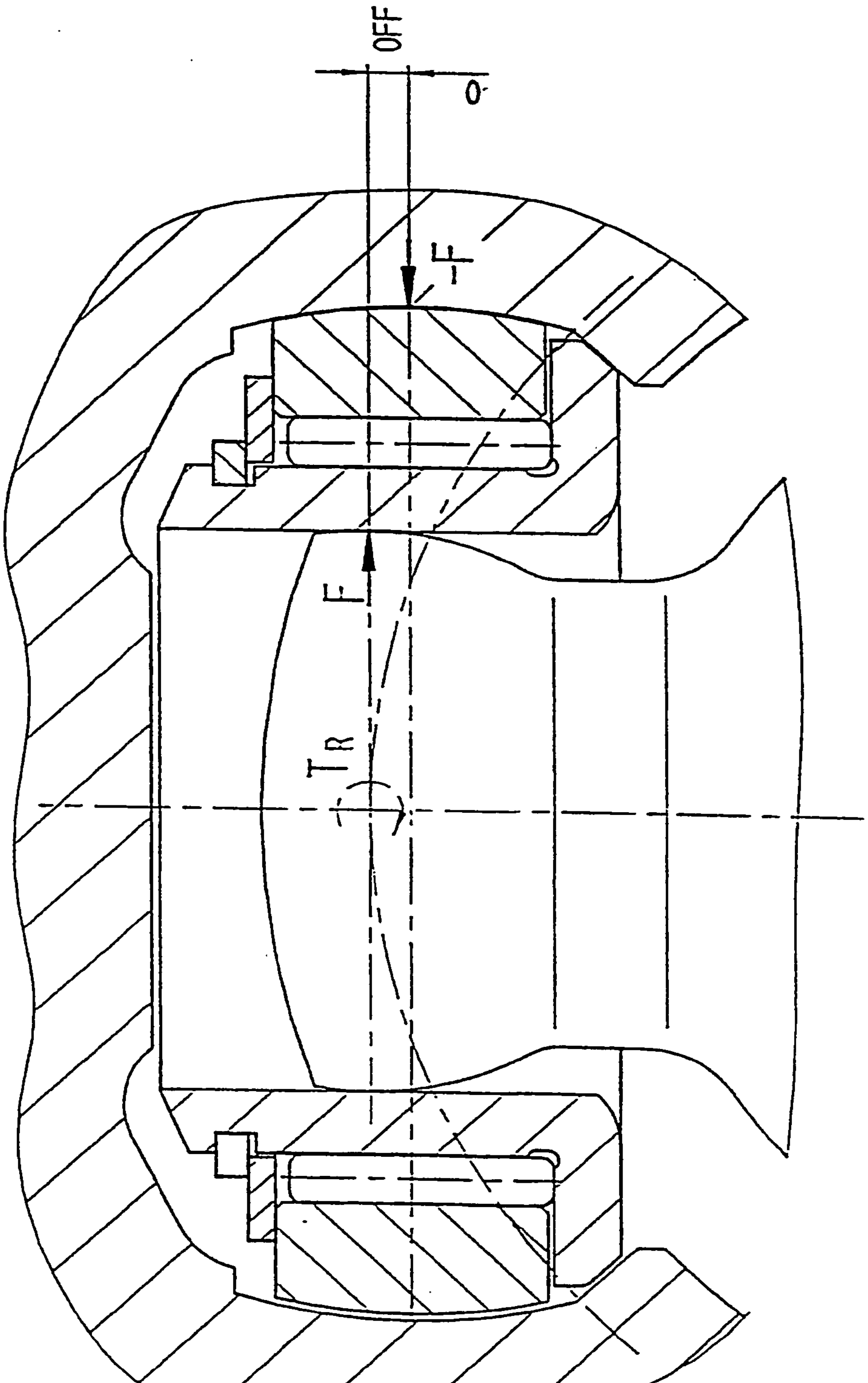


FIG 7b

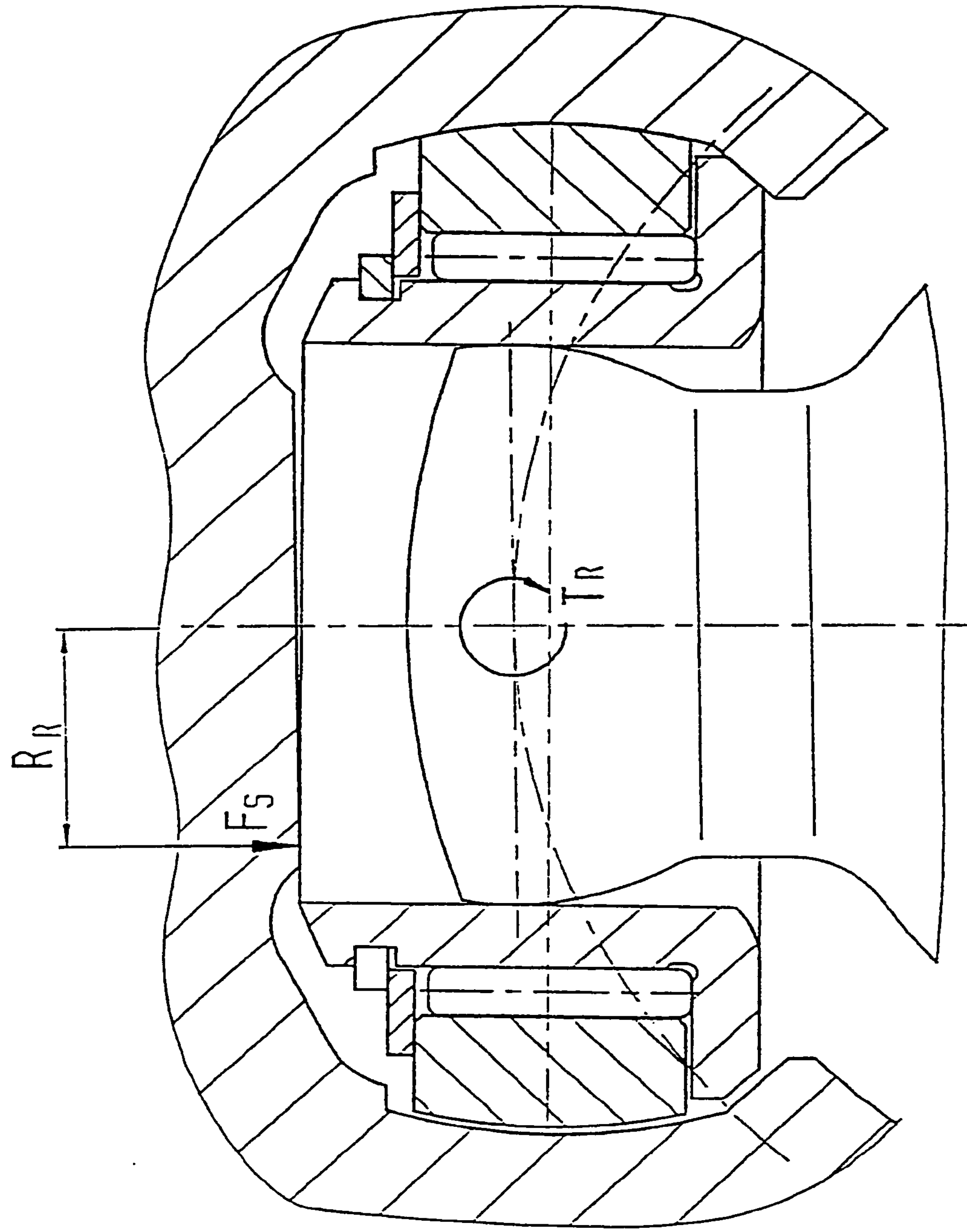


FIG 7c

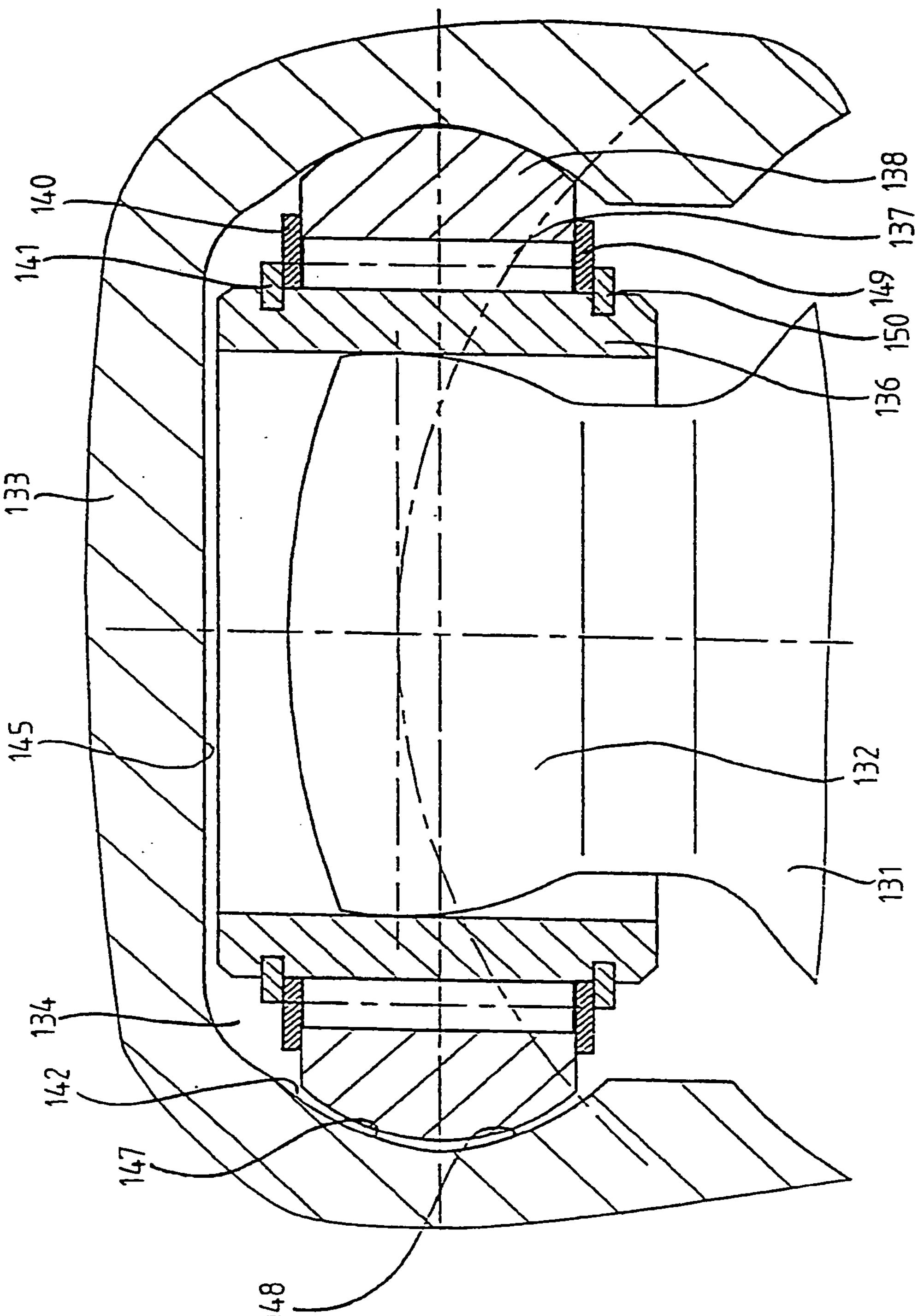


FIG 8a

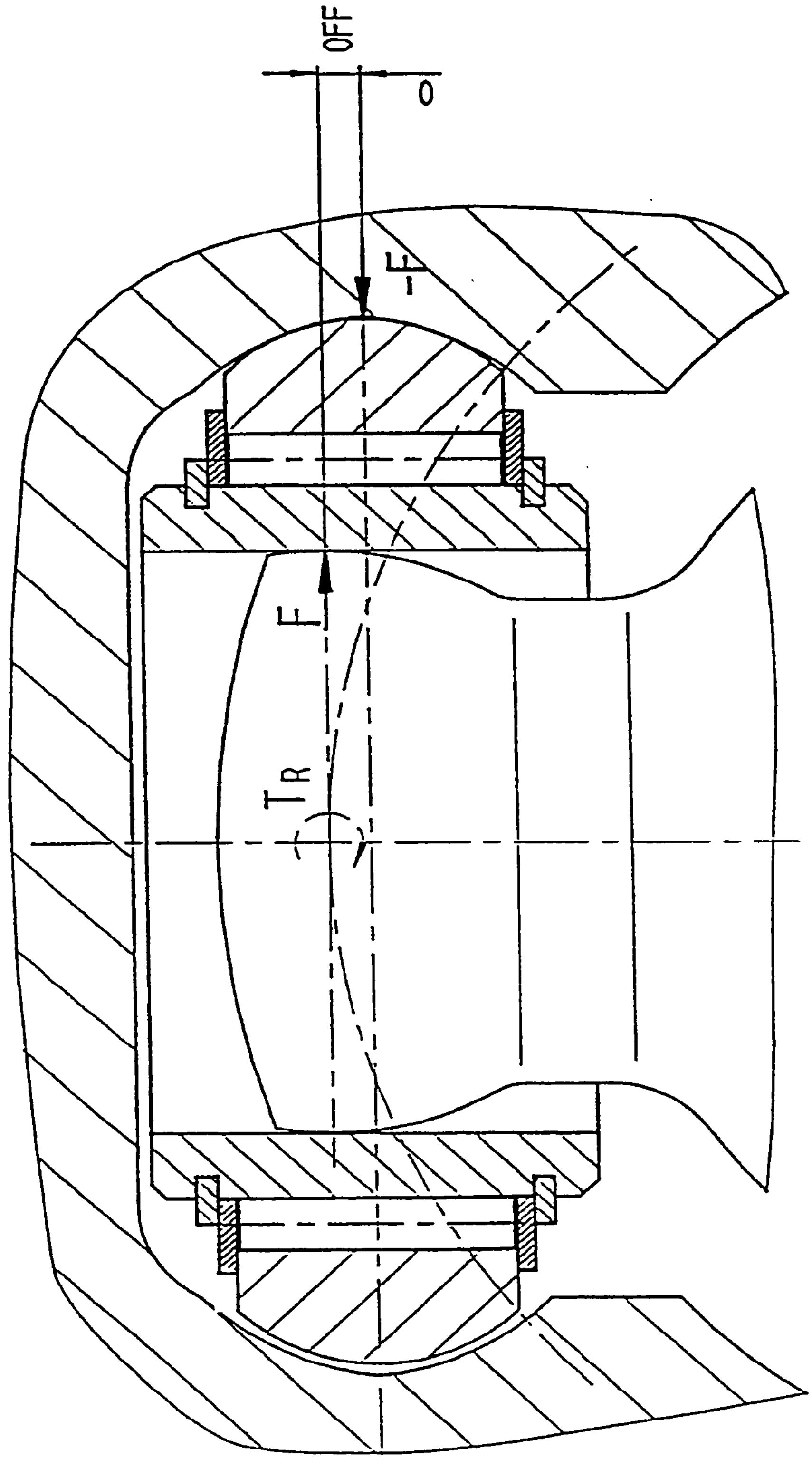


FIG 8b

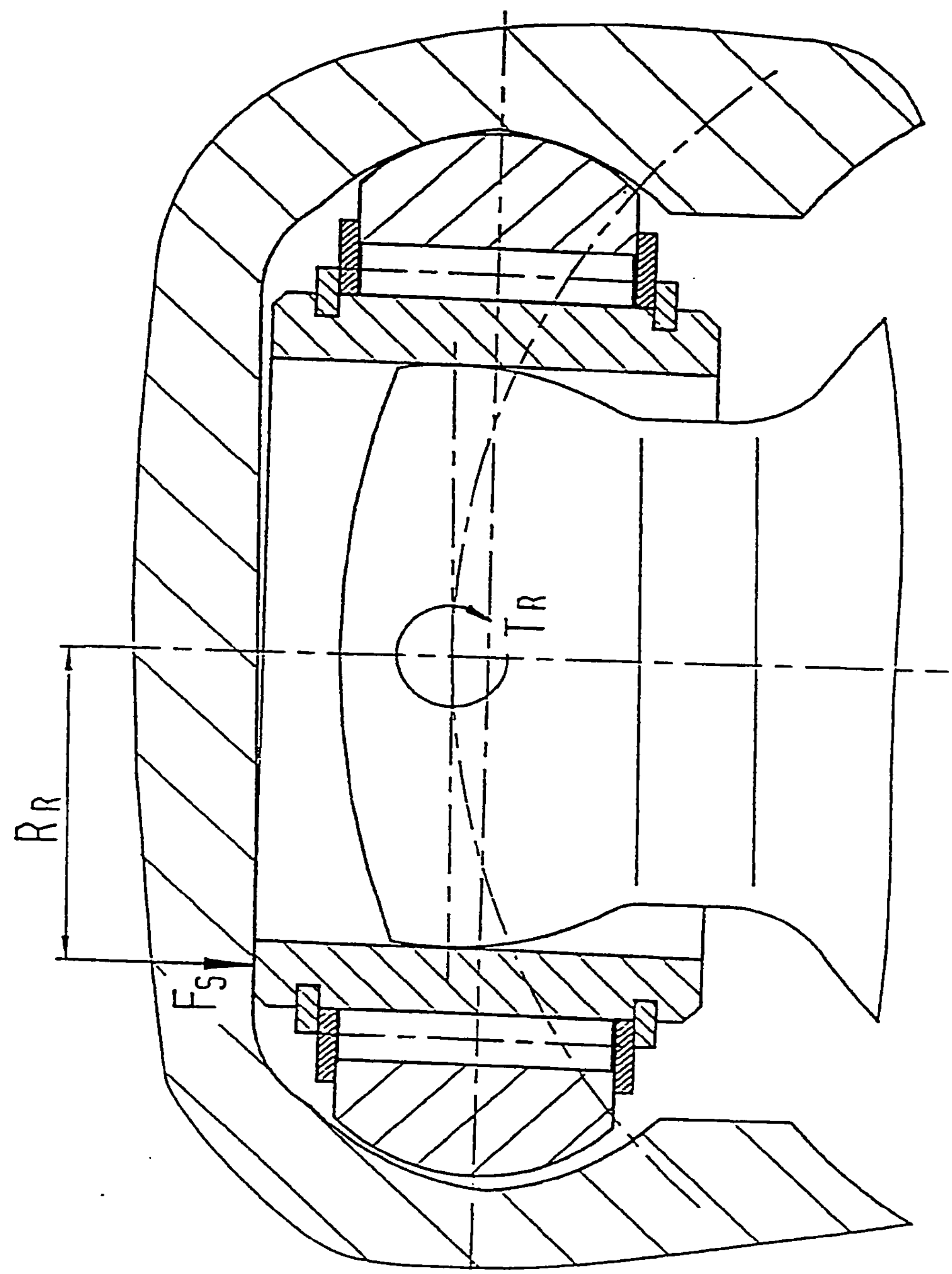


FIG 8C

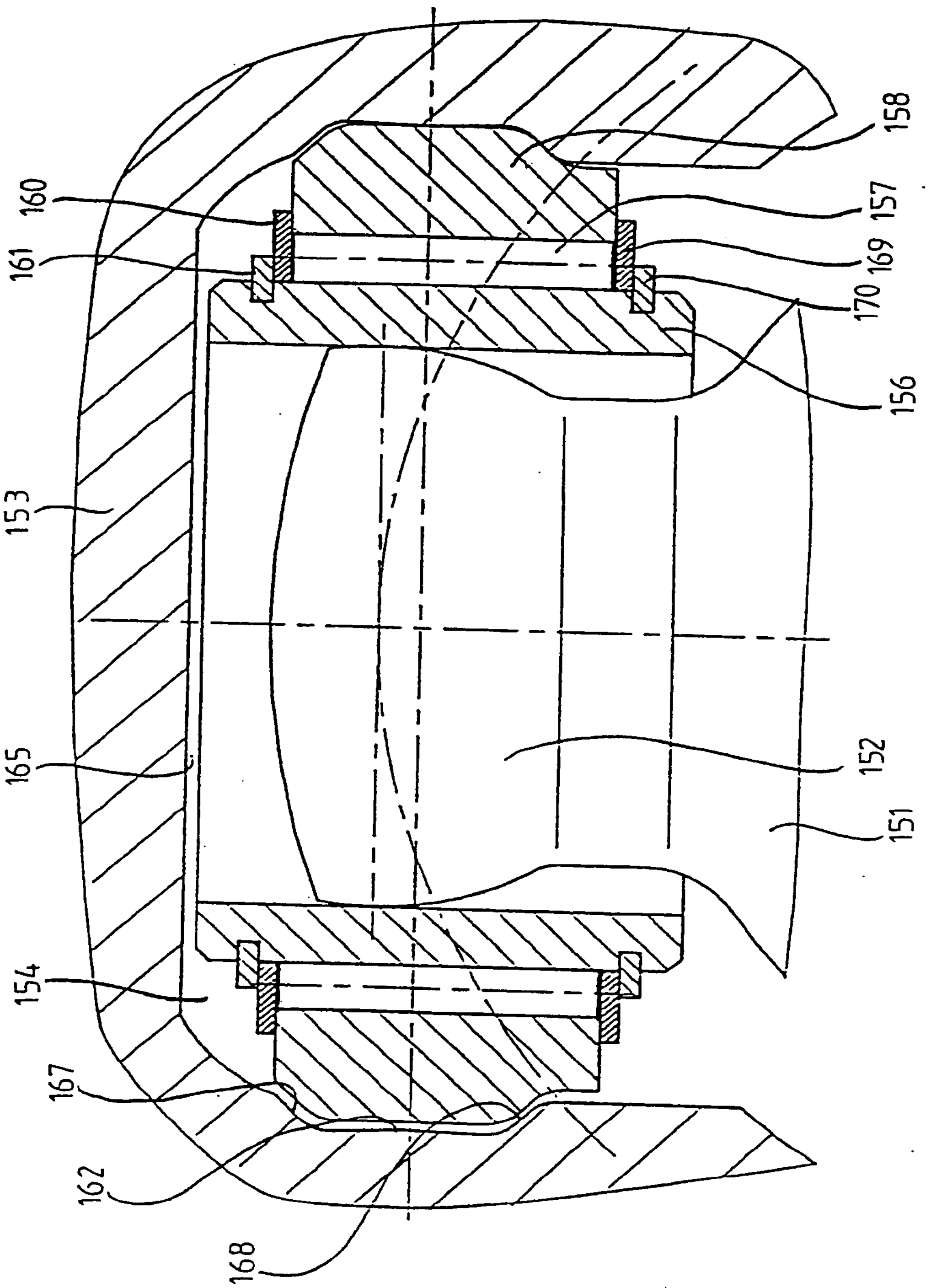


FIG 9a

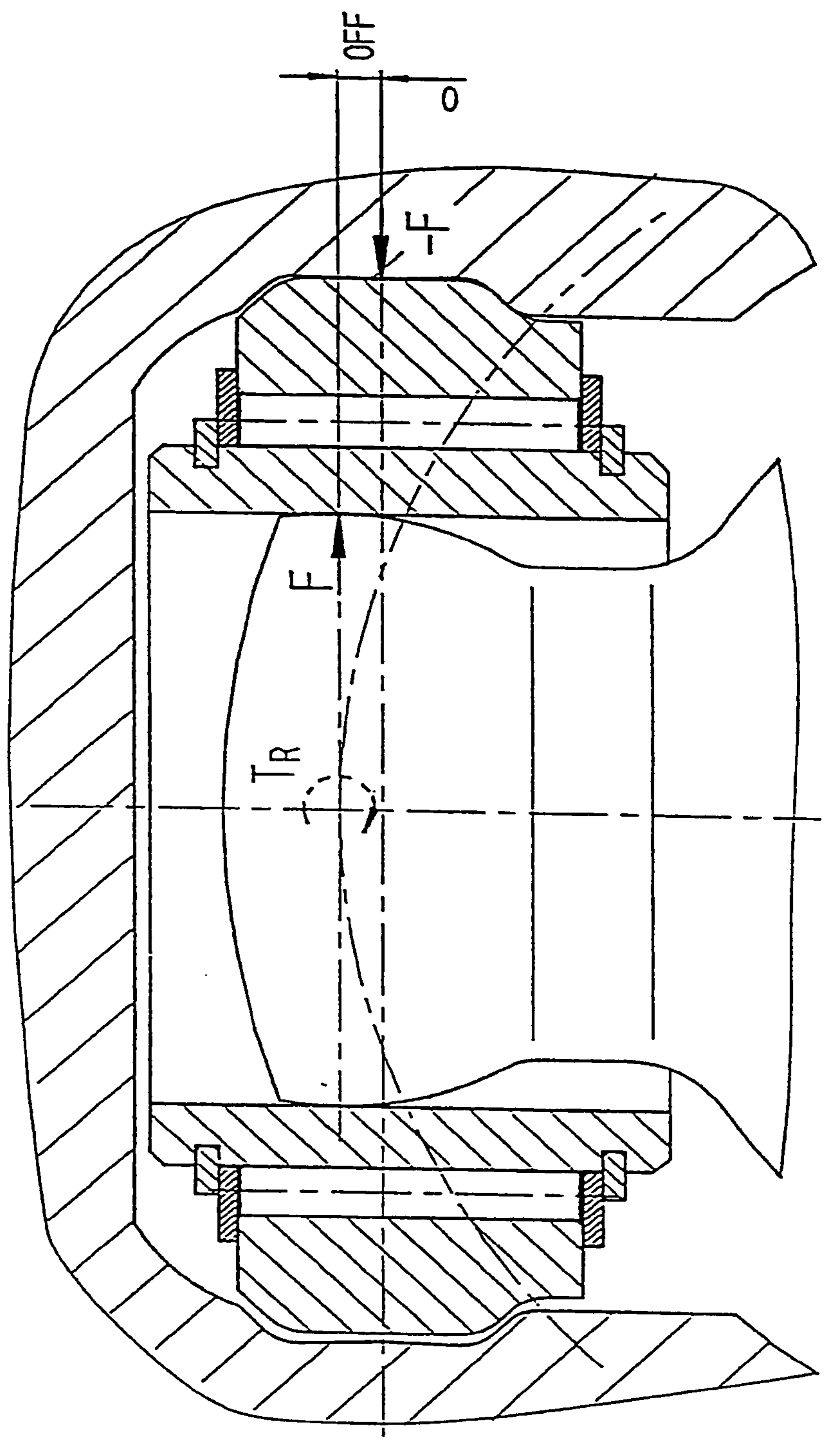


FIG 9b

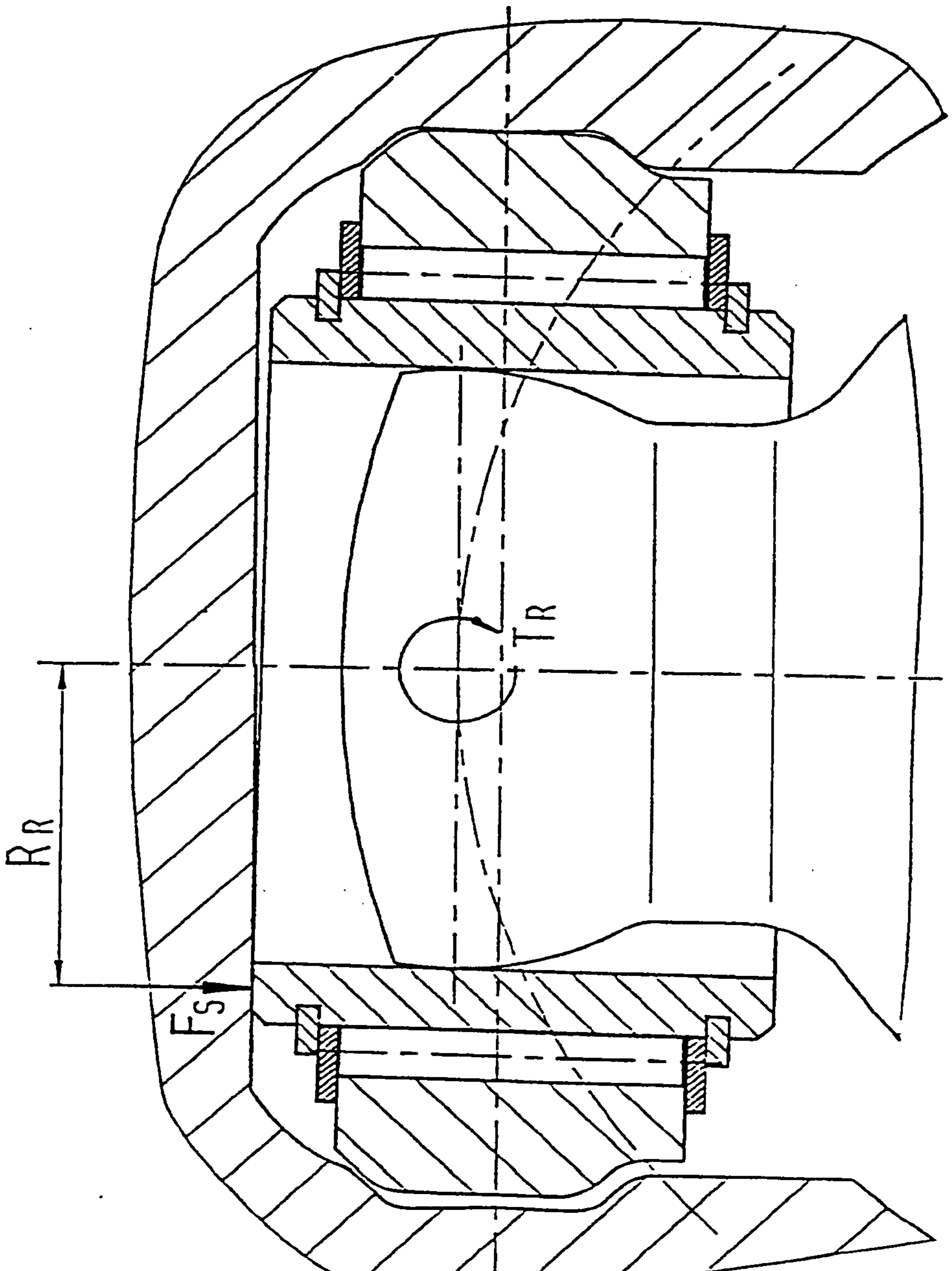


FIG 9C

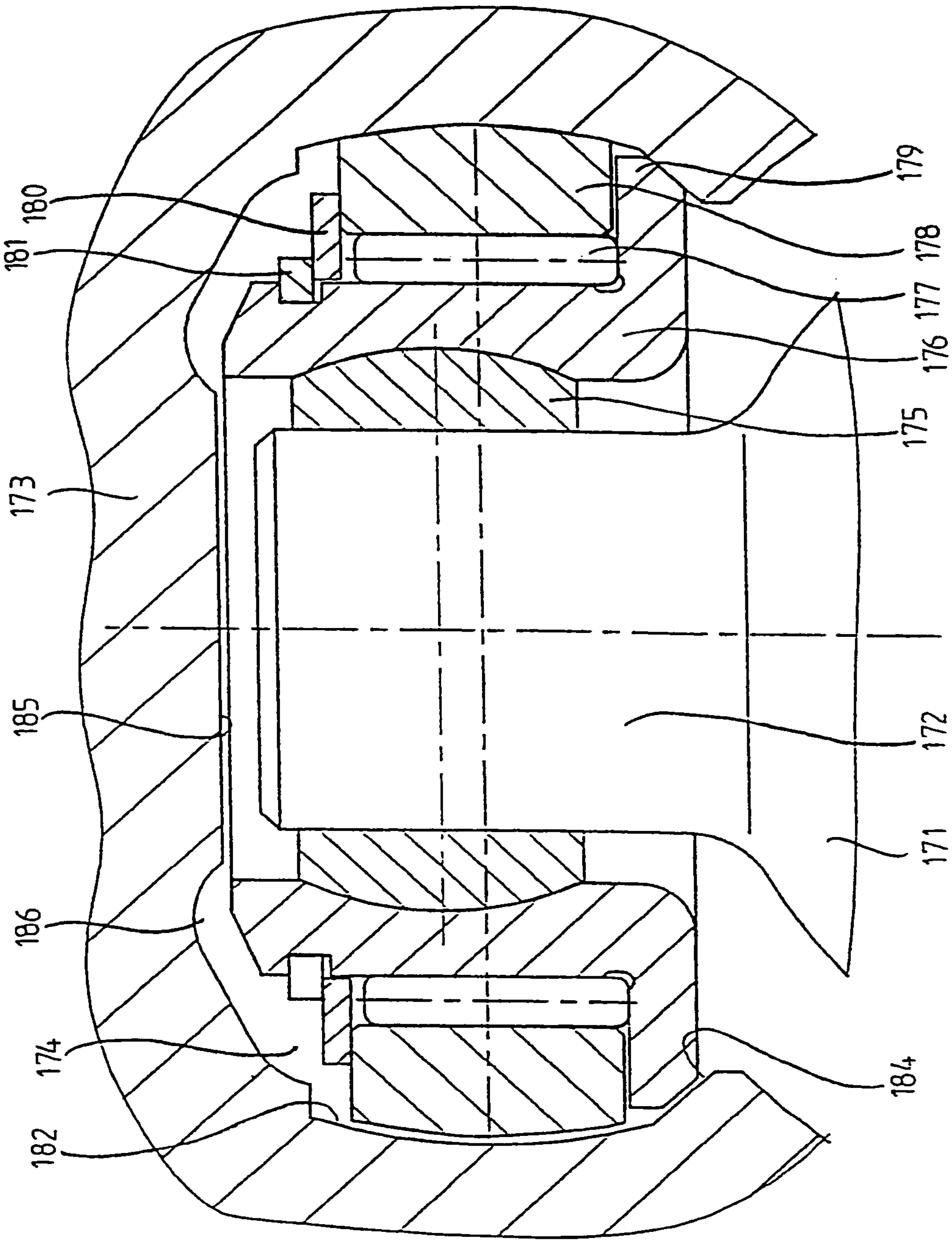


FIG 10

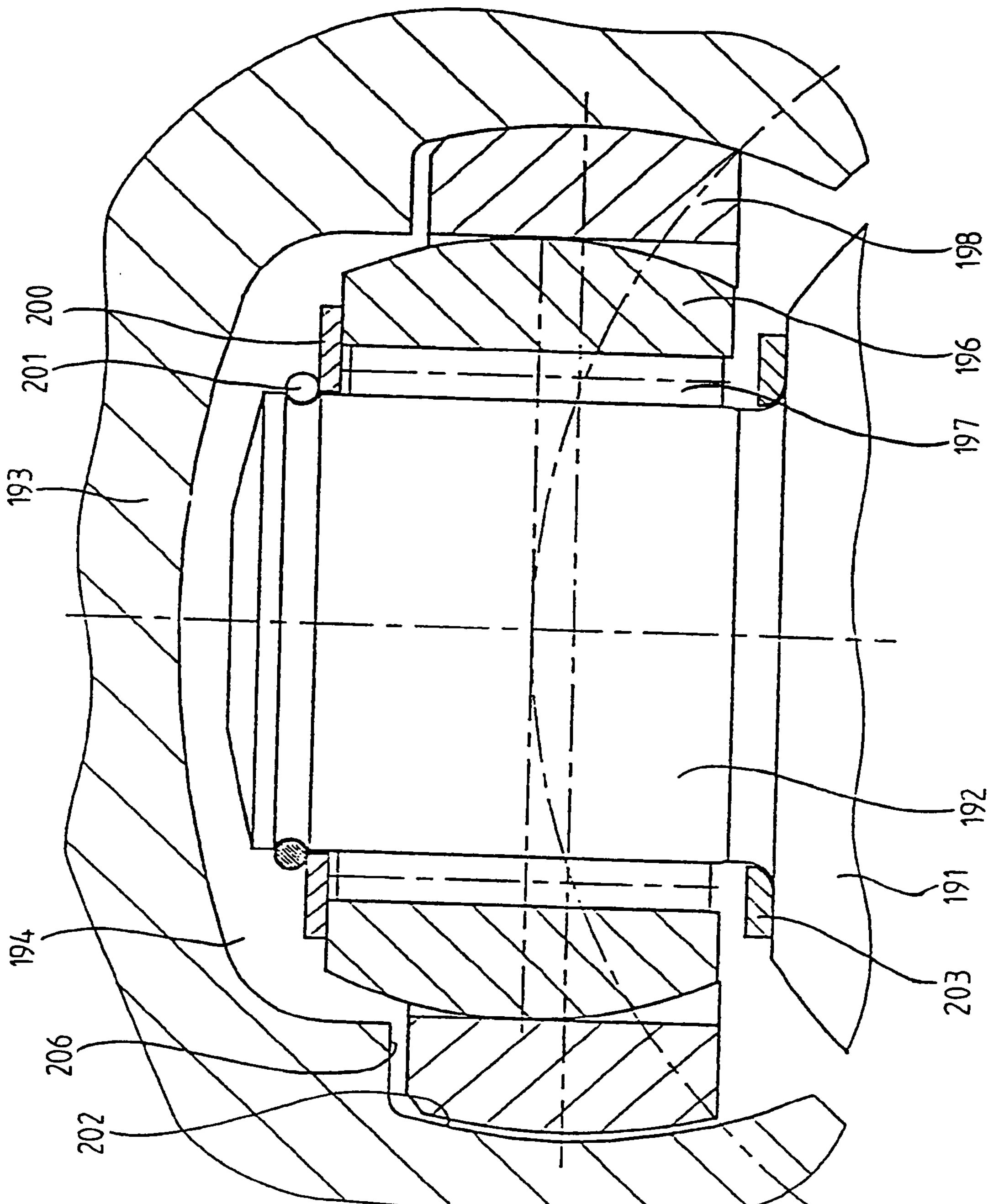


FIG 11

Title: TRIPODE JOINTS

Description of Invention

This invention relates to universal joints, for torque transmission, of the tripode type, such a joint comprising an outer joint member having three circumferentially spaced recesses extending parallel to its rotational axis and each defining opposed tracks, and an inner joint member having three circumferentially spaced arms extending into the recesses in the outer joint member, the arms supporting respective roller assemblies each comprising a roller engaging the tracks and means carrying the roller relative to the arm so that the roller is movable lengthwise of the arm and is able to rotate about and pivot relative to the arm.

Tripode joints as above described are known in various designs, e.g. for example from DE-2831044 (Honda), DE-3936601 (GKN) and DE-3716962 (NTN).

When such a tripode joint rotates in the articulated condition (i.e. with the rotational axes of the inner and outer joint members inclined to one another), the rollers oscillate radially relative to the rotational axis of the inner joint member and pivot cyclically with respect to the axes of the arms of the inner joint member. At the same time, the rollers oscillate in a rolling movement along the tracks of the outer joint member while remaining in a substantially constant orientation in the tracks. The radial and pivoting movements first mentioned involve sliding frictional conditions, whereas the movements of the rollers along the tracks in the outer joint member are predominantly under rolling contact conditions. Because of the frictional forces, tripode joints as generally known in the prior art are subject, with an increasing angle of articulation, to a considerable increase in joint excitation forces, i.e. cyclic forces generated in the joint and which are transmitted to the drive line in which the joint is utilised. Because of wear resulting therefrom, and the development of noise and vibration, such

excitation forces are highly undesirable. Additionally, in some cases, joint excitation forces scatter from joint to joint, sometimes even within an individual joint during operation. The cause may be regarded as being an unstable behaviour of each roller in the tracks of the joint when it rotates in the articulated condition, which may lead to different and varying contact and frictional conditions on the various contact faces within the roller assembly and on the contact faces of the roller with the tracks.

It is the object of the present invention to provide a joint of the tripode type wherein the frictional conditions in the joint can be improved and, in consequence, the joint excitation forces are preferably reduced and predeterminable.

According to the present invention, therefore, we provide a tripode joint wherein for each roller any part-spherical surface of the arm or of the roller-carrying means, and cooperating part-spherical or cylindrical internal surface of the roller-carrying means or roller respectively, on the one hand; and the outer surfaces of the roller and track surfaces engaged thereby, on the other hand; are so arranged that when the joint is transmitting torque, and considered in the aligned (non-articulated) condition, the resultant of forces acting on the roller through the first mentioned surfaces is at a perpendicular distance from the axis of rotation of the joint different from the perpendicular distance from the axis of rotation of the joint of the resultant of forces acting on the roller from the outer joint member, so that the roller is subject to a tilting moment about its region of contact with that one track (referred to herein as the loaded track) of said opposed tracks which is subjected to load when the joint is transmitting torque.

When we refer to the loaded track, and to the loaded side of the recess, it will be appreciated that under torque transmission in a given direction the track at one side of the recess only will be subject to torque-transmitting forces, and we mean this track and this side of the recess.

In principle, this means that the application point of the resultant of the torque-transmitting forces applied by the respective tripode arm of the inner

joint member directly to the inner surface of the associated roller is located so as to be asymmetric, i.e. offset radially inwardly or outwardly of the joint, relative to the application point of the resultant of forces applied by the respective track to the outer surface of the roller, so that the tilting moment is generated. It will be appreciated that when we refer to the application point of the forces to the surface of the roller, because there are provided roller assembly elements which transmit the forces, we refer to the point of intersection between the line of application of the resultant forces and the respective inner or outer roller surface. In view of the fact that the joint in accordance with the invention may already be articulated when it is installed, the radial perpendicular distance between the two force application lines, with respect to the axis of the outer joint member has to be such that the direction of rotation of the tilting moment acting on the roller remains in the same direction under all operating angles of articulation.

The advantageous effect of the above measures is that when torque is being transmitted by the joint, stable contact conditions of the roller assemblies relative to the recesses in the outer joint member are ensured, independently of the speed of rotation and angle of articulation of the joint, so that under all operating conditions there exist foreseeable contact conditions and thus defined frictional conditions which determine the joint excitation forces. In consequence, these frictional conditions may be positively influenced by advantageously determining the position and design of the respective contacting surfaces. Such positive influences may be exerted by suitably designing the roller assemblies and recesses, especially by suitable design of radially outer and/or inner supporting faces by which the rollers are supported against tilting in the tracks, and by determining the radial play between the rollers and such supporting faces.

The resultant of forces acting on the roller through the first mentioned surfaces may be at a perpendicular distance from the axis of rotation of the joint which is smaller than the perpendicular distance from the axis of the joint of the resultant of forces acting on the roller from the outer joint member, so that the

roller is subject to a tilting moment which tends to tilt it inwardly towards the joint axis about its contact with the loaded track.

Alternatively the resultant forces acting on the roller through the first mentioned surfaces may be at a perpendicular distance from the axis of rotation of the joint which is greater than the perpendicular distance from the axis of rotation of the joint of the resultant of forces acting on the roller from the outer joint member, so that the roller is subject to a tilting moment which tends to tilt it outwardly about its contact with the loaded track.

The outer joint member may be provided with supporting faces radially inwardly or outwardly of the roller assemblies, with references to the axis of the joint, engagable with elements of the roller assemblies to support the rollers against tilting in response to said tilting moment. It is advantageous if the contact between such supporting faces and parts of the roller assemblies takes place at a radius with reference to the axis of the arm which is greater than the difference between said perpendicular distances from the axis of rotation of the joint of the resultants of forces acting on the roller.

Supporting faces whose purpose is to counteract tilting of the rollers or roller assemblies in response to said tilting moment may be provided by suitably shaping the cross-sectional shapes of the tracks in the outer joint member and the outer surfaces of the rollers engagable therewith. For example, the outer surfaces of the rollers may be arcuate in cross-sectional shape whilst the cross-sectional shape of each track is that of a "gothic arch".

The recess and an element of the roller assembly may be provided with supporting faces arranged so that at the part of the recess which is subjected to loads when torque is being transmitted, the roller assembly displaced by the tilting moment is supported on faces which are located radially outside the roller assembly having regard to the axis of the joint, whilst on the side of the recess which is not subjected to loads the roller assembly is supported on faces which are located radially inside the roller assembly with reference to the axis of the joint.

Alternatively, when the tilting moment is such as to tilt the roller outwardly about its region of contact with the loaded track, an element of the roller assembly may have a supporting face arranged to engage a supporting face at the recess side which is not subject to load when torque is being transmitted, radially outside of the roller assembly. Such a supporting face may advantageously be provided on a smaller diameter than a supporting face which is positioned radially inside of the roller assembly in the recess side which is subject to loads during transmission of torque.

When the roller assembly is not displaced under the tilting moment, there may be provided a radial clearance between the elements of the roller assembly and the supporting faces of the recess in the outer joint member.

The invention may be applied to various types of tripode joint, e.g. the designs of joint referred to hereinbefore.

The invention will now be described by way of example with reference to the accompanying drawings, of which:-

Figure 1 is an axial view, partly in section, of a first embodiment of tripode joint according to the invention;

Figure 2 is an axial view, partly in section, of a further embodiment of tripode joint according to the invention;

Figure 3 is an axial view, partly in section, of yet a further embodiment of tripode joint according to the invention;

Figure 4 is an enlarged detail of part of Figure 1;

Figure 5 is an enlarged detail of part of Figure 2;

Figure 6 is an enlarged detail of part of Figure 3;

Figure 7a is a detail on an enlarged scale of part of a joint according to the invention, at the moment of torque application;

Figure 7b shows the joint of Figure 7a including the forces acting on the illustrated roller;

Figure 7c shows the joint of Figure 7a with the roller tilted in response to the forces shown in Figure 7b;

Figure 8a shows an enlarged detail of a further embodiment of joint according to the invention, at the moment of torque introduction;

Figure 8b shows the joint of Figure 8a and the forces acting on the roller thereof;

Figure 8c shows the joint of Figure 8a with the roller tilted under the influences of the forces shown in Figure 8b;

Figure 9a shows an enlarged detail of a third embodiment of joint according to the invention, at the moment of torque introduction;

Figure 9b shows the joint of Figure 9a and the forces acting on the rollers thereof;

Figure 9c shows the joint of Figure 9a with the roller tilted under the influence of the forces shown in Figure 9b;

Figure 10 is an enlarged detail of yet a further embodiment of joint according to the invention;

Figure 11 is an enlarged detail section of yet a further embodiment of joint according to the invention.

In each of the drawings, the respective joint is illustrated in the aligned (non-articulated) condition wherein the rotational axes of the inner and outer joint members coincide, and when we refer to the axis of the joint we mean such common axis of the joint members in the illustrated condition.

Referring firstly to Figures 1 and 4 of the drawings, these show a tripode joint which comprises an inner joint member 11 generally of annular form, having externally cylindrical arms 12 circumferentially spaced around and extending radially outwardly therefrom. The arms extend into recesses 14 in an outer joint member 13, the arms 12 carrying respective roller assemblies which engage the outer joint member for torque transmission.

Each roller assembly comprises an inner roller element 15 which has an internal cylindrical surface and part-spherical external surface. By virtue of its cylindrical internal surface engaging the cylindrical surface of the arm, the inner roller element is able to move lengthwise on the arm, i.e. radially of the joint as

a whole. On the exterior of the inner roller element 15 there is held a roller carrier element 16 which has an internal part-spherical surface by which it is able to pivot universally on the inner roller element 15. A roller 18 is rotatable about the roller carrier element 16, with a needle roller bearing assembly 17 interposed therebetween. Roller 18 is held captive on the roller carrier element 16 between a flange or collar 19 on the roller carrier at the part thereof which lies radially innermost with respect to the joint as a whole, and a retaining washer 20 held by a retaining ring 21.

The external surface of the roller 18, which is of part-spherical configuration, engages opposed tracks 22 at opposite sides of the recess 14. Each track 22 has a groove 23 for lubricant. Radially inwardly of the roller assembly, the opposed sides of the recess 14 are provided with respective shoulders 24 of which one is arranged to be subjected to loads during torque transmission while the other is to be kept load-free. The roller carrier element 19 is also able to be supported on a supporting face 25 of the outer joint member, radially outside the roller assembly with regard to the axis of the joint and facing such axis. The supporting face 25 is provided only in a region of the recess 14 close to the axis of the arm 12: otherwise the recess 14 extends in regions 26 radially of the joint outwardly beyond the face 25.

In Figure 4, chain-dotted lines show the line K1 of action of the resultant of torque transmitting forces acting from the arm 12 on the inner roller element 15 and thus indirectly on the inside of the roller 18. K2 is the line of action of the resultant of forces acting from the loaded track directly on the outside of the roller 18. These lines are offset from one another by a distance "a" radially of the joint as a whole, so that when torque is being transmitted the roller is subject to a tilting moment TR tending to tilt the roller inwardly about its region of contact with the track 22 which is loaded when torque is being transmitted. The geometry is such that a radial distance "a" is maintained under all angles of joint articulation encountered in service, so that the tilting moment TR always is in the same sense.

Figures 2 and 5 of the drawings show a further embodiment of tripode joint comprising an annular inner joint member 31 having circumferentially spaced radially outwardly extending arms 32 each of which has a part-spherical external surface portion. An outer joint member 33 having circumferentially spaced axially extending recesses 34 receives the inner joint member, and there are respective roller assemblies by which torque is transmitted between the joint members by way of the arms of the inner joint member and recesses of the outer joint member.

Each roller assembly comprises a roller carrier 36 having a cylindrical internal surface which fits on the part-spherical surface of the respective arm so as to be radially movable relative to the axis of the joint and pivotable relative to the arm. The roller carrier 36 has at its part which is radially innermost of the joint a flange or collar formation 39 and a wear-resistant insert 48 is provided at the transition between the internal cylindrical surface of the roller carrier and the collar 39. A roller 38 is supported on the roller carrier 36 by way of a needle roller bearing assembly 37 and is retained between the collar 39 and a retaining washer 40 and retaining ring 41.

Each recess 34 has opposed tracks 42 of part-cylindrical configuration, and shoulders 44 at the radially innermost part of the recess. Further, the recess has a supporting face 45 at its radially outermost part, arranged to contact the roller carrier at one side when torque is being transmitted. The collar 39 of the roller carrier 36, at the side of the recess 34 which is subject to load when torque is being transmitted, has to be contact free at all angles of joint articulation. In the side of the recess 34 which is subject to loads when torque is being transmitted, the roller carrier 36 is to be supported only by the supporting face 45 at a diameter (relative to the axis of the roller carrier 36) which is considerably smaller than that of the collar 39. This is achieved by arranging for a tilting moment TR to be produced on the roller assembly when torque is being transmitted, which tilting moment results from an offset by a distance "a" between the line of application K1 of the resultant of torque-transmitting forces applied

by the arm 32 to the roller carrier 36, and thus indirectly to the roller 38 on the interior surface thereof, and the line of application K2 of the resultant of forces applied by the loaded track 42 directly to the roller on the external surface thereof.

The positive distance "a" between the two lines of application of such forces is to be maintained at all angles of joint articulation, thereby ensuring that the frictional forces applied to the supporting face 45 by the roller carrier 36 are low, so that there occurs no rotational movement of the roller carrier relative to the arms 32. As a result of this any wear at the substantially linear contact region between the arm and roller carrier is avoided.

Referring now to Figures 3 and 6 of the drawings, these show an inner joint member 51 with circumferentially spaced radially outwardly extending arms 52, and an outer joint member 53 with circumferentially spaced axially extending recesses 54 into which the arms 52 extend. Respective roller assemblies are provided on the arms, each comprising an inner roller 56 which is rotatably supported, by a needle roller bearing assembly 57, on the external cylindrical surface of the arm. The inner roller 56 has a part-spherical external surface, which engages an internal cylindrical surface of roller 58. The roller is thus able to pivot relative to the inner roller 56 and move lengthwise of the arm, whilst rotation of the roller about the arm takes place at the needle roller bearing assembly 57 between the inner roller element and arm. The external surface of the roller 58 engages opposed tracks 62 at opposite sides of the recess 54. A retaining ring 60 and washer 61 retain the inner roller 56 and needle roller bearing assembly 57 on the arm.

The line of application K1 of the resultant of torque-transmitting forces F applied to the roller 58 from the arm 52, indirectly by way of the inner roller element 56, is offset radially of the joint as a whole by a distance "a" from the line of action K2 of the resultant of forces -F applied to the external surface of the roller 58 by the outer joint member. This produces a tilting moment TR

on the roller, which is resisted by engagement of the roller with a supporting face 65 adjacent each track 62 in the recess 54.

The arrangement is such that a positive distance "a" is maintained under all angles of joint articulation, so that the tilting moment TR always acts in the same sense.

In each of Figures 4 to 6, the respective embodiment of joint according to the invention is shown subject to the forces arising when torque is being transmitted. In each case, the inner joint member is the driving member and the outer joint member is the driven member, and torque is being transmitted in a clockwise sense with reference to the drawing. The resultant of forces acting on the interior roller from the arm by way of the roller assembly components, and on the exterior of the roller from the outer joint member, are indicated by the symbols -F and F. As a result of the distance between the two lines of application of such forces, the tilting moment TR is produced on the roller assembly, which is resisted by supporting forces Fsa on supporting faces radially outside the roller assembly or roller, with reference to the axis of the joint.

Figures 7a to 7c show part only of a universal joint which is similar, in respect of its roller assembly design, to the joint of Figures 2 and 5 of the drawings. An inner joint member 111 has an arm 112 extending radially outwardly therefrom, with an external part-spherical surface. The arm extends into a recess 114 in an outer joint member 113, and a roller assembly provides the torque transmission between the inner and outer joint members. The roller assembly comprises a roller carrier 116 having an internal cylindrical surface engaging the part-spherical surface of the arm 112, so as to be pivotable on the arm and movable lengthwise of the arm, i.e. radially relative to the joint axis. The roller carrier 116 carries a roller 118 with an interposed needle roller bearing assembly 117, the roller 118 being constrained by a collar 119 at the radially innermost part of the roller carrier 116 and a retaining washer 120 and retaining ring 121. The recess 114 has opposed tracks 122 of part-cylindrical cross-sectional

shape, and shoulders 124 at the radially innermost part of the recess. Further, the recess 114 has an outer supporting face 125.

Figure 7a shows the joint as torque is about to be introduced, in the clockwise sense to be transmitted from the inner joint member to the outer joint member. The track 122 to the right of the drawing is in contact with the external surface of the roller 118.

Figure 7b shows the offset, radially of the joint as a whole, between the resultant F of forces acting between the arm and inner roller element and thus on the interior of the roller, and the resultant -F of forces acting on the exterior of the roller from the outer joint member. The force F acts at a distance from the axis of the joint greater than the opposed force -F, so that a tilting moment TR acts on the roller.

Figure 7c shows how, as a result of the tilting moment TR applied to the roller, the roller tilts slightly in the track about its engagement with the right hand track. The tilting takes place about an axis which is parallel to the joint axis. In the process, the collar 119 is supported on the shoulder 124 at the loaded side of the recess 114, whilst the roller carrier 116, at its end face radially outermost of the joint, is supported on the outer supporting face 125 of the recess. A supporting moment acting against the tilting moment TR is generated by the supporting force FS at a distance RR from the axis of the arm. The distance OFF between the lines of action of the forces F and -F is to remain positive at all angles of joint articulation, so that the friction forces acting on the supporting face 125 where it engages the roller carrier 116 are low, which means that there occurs no rotational movement of the roller carrier relative to the arm 112. Thus wear at the substantially linear contact region between the two is avoided.

Figures 8a to 8c show a further embodiment of joint, in views as Figures 7a to 7c. Any parts of such joint corresponding to those above described in relation to Figures 7a to 7c have been given reference numerals increased by 20 compared with those in Figures 7a to 7c. In contrast to the joint of Figures 7a to 7c, the tracks 142 each comprise two part-cylindrical portions 147, 148

whose central axes are offset relative to one another so that the tracks have a cross-sectional shape of a so-called gothic arch. In the section illustrated, the radius of curvature of each of the two parts of the gothic arch is greater than the radius of curvature of the external surface of the roller 138. The joint differs further in that the roller 138 is secured to the roller carrier 136 both inwardly and outwardly of the joint by respective washers 140, 149, and retaining rings 141, 150. The design of the track ensures that, independently of the application point of the force F, the application point of the force -F changes only slightly.

Figures 9a to 9c show a further embodiment of joint in views corresponding to those of Figures 7a to 7c. Any components corresponding to those shown in Figures 8a to 8c have been given reference numerals further increased by 20. In Figures 9a to 9c, reference is made particularly to the cross-sectional shape of the tracks 162 and of the external surface of the roller 158. Whereas the cross-sectional shape of the track 162 is convex in its central region and provides two shoulders 167, 168, the roller 158 has an external cylindrical portion and is provided with shoulders which are cooperable with the shoulders 167, 168 of the tracks. This track shape also ensures that with a radially changing line of action of force F, the counterforce -F substantially retains the same application point.

Figure 10 shows a section through part of a tripode joint comprising an inner joint member 171, an arm 172 extending radially outwardly from the inner joint member, and having a cylindrical external surface, and an outer joint member 173 with a recess 174 into which the arm extends. A roller assembly comprises an inner ring 175 with a cylindrical internal surface engaging the external surface of the arm, and an external part-spherical surface. The inner ring 175 is thus movable lengthwise of the arm 172, i.e. radially with respect to the axis of the joint as a whole. The inner ring 175 holds a roller carrier 176 which has an internal part-spherical surface engaging the external surface of the inner ring so as to be pivotable thereon. A roller 178 is rotatable on the roller carrier 176 with a needle roller bearing assembly 177 interposed therebetween. The needle

bearing assembly and roller are constrained between a collar 179 at the innermost part of the roller carrier 176, and a retaining washer 180 secured by a retaining ring 181 at the outermost part of the roller carrier. The external surface of the roller engages, according to which direction torque is being transmitted, one of opposed tracks 182 at opposite sides of the recess 174. Radially inwardly of each track 182 the recess 174 of the outer joint member is bounded by shoulders 184 engagable with the collar 179 of the roller carrier 176. When the joint is transmitting torque, the shoulder 184 adjacent the track 182 which is not subject to loads does not contact the collar 179. At the part of the recess 174 not subject to loads when torque is being transmitted, the roller carrier 176 may support itself at its radially outermost part on a supporting face 185 in the outer joint member. The recess 174 extends radially outwardly beyond the face 185 in regions 186, so that the face 185 is restricted to a region close to the axis of the arm.

Two chain-dotted lines indicate the lines of application of the resultants of torque-transmitting forces acting from the arm on the inner ring 175 and thus indirectly on the interior of the roller 178, and from the relevant track 182 directly on the external surface of the roller 178. These lines maintain a positive radial distance from one another at all operating angles of articulation of the joint. As a result, a tilting moment is applied in the clockwise sense to the roller, causing tilting of the roller, and with it the inner roller, about the track which is loaded when torque is being transmitted.

Figure 11 shows in section part of a further embodiment of joint, comprising an inner joint member 191 with one of three arms 192 extending radially outwardly therefrom into a recess 194 in an outer joint member 193. The arm 192 carries a roller assembly, comprising an inner roller 196 which by way of a needle roller bearing assembly 197 is rotatable on an external cylindrical surface of the arm 192. The inner roller element 196 and bearing assembly 197 is retained on the arm by a retaining washer 200 and retaining ring 201. The inner roller 196 has a part-spherical external surface, and supports a roller 198 having an internal cylindrical surface so that it is radially movable and pivotable with

respect to the inner roller and thus relative to the arm. The external surface of the roller engages tracks 202 in opposite parts of the recess 194. The inner roller 196 is movable a small distance lengthwise of the arm 192 and a stop ring 203 is provided where the arm joins the inner joint member to prevent the inner roller from contacting the inner joint member.

The lines of action of the resultant of torque-transmitting forces respectively applied to the interior of the roller 198 by the inner roller and to the exterior of the roller by the track are indicated by chain-dotted lines, the former line being at a greater distance from the rotational axis of the joint as a whole than the latter. Under all operating conditions, at all angles of joint articulation, a positive distance has to be maintained between the two lines of application of such forces so that a tilting moment is applied to the roller clockwise and outwardly about the right hand track, if it is assumed that this track is loaded when torque is being transmitted. When the roller 198 tilts as a result of such tilting moment, it is supported on supporting faces 206 adjacent the tracks 202 in the recess 194.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A universal joint, for torque transmission, of the tripode type, comprising an outer joint member having three circumferentially spaced recesses extending parallel to its rotational axis and each defining opposed tracks, and an inner joint member having three circumferentially spaced arms extending into the recesses in the outer joint member, the arms supporting respective roller assemblies each comprising a roller engaging the tracks and means carrying the roller relative to the arms so that the roller is movable lengthwise of the arm and is able to rotate about and pivot relative to the arm; wherein, for each roller, any part-spherical surface of the arm or of the roller-carrying means, and cooperating part-spherical or cylindrical internal surface of the roller-carrying means or roller respectively, on the one hand; and the outer surfaces of the roller and the track surfaces engaged thereby on the other hand; are so arranged that when the joint is transmitting torque and considered in the aligned condition, the resultant of forces acting on the roller through the first mentioned surfaces is at a perpendicular distance from the axis of rotation of the joint different from the perpendicular distance from the axis of rotation of the joint of the resultant of forces acting on the roller from the outer joint member, so that the roller is subject to a tilting moment about its region of contact with that one track (referred to herein as the loaded track) of said opposed tracks which is subjected to load when the joint is transmitting torque.

2. A joint according to Claim 1 wherein the resultant of forces acting on the roller through the first mentioned surfaces is at a perpendicular distance from the axis of rotation of the joint less than the perpendicular distance from the axis of rotation of the joint of the result out of forces acting on the roller from the outer joint member, so that the roller is tilted inwardly towards the joint axis about its contact with the loaded track.

3. A joint according to Claim 2 wherein the outer joint member and roller assembly have supporting faces arranged so that at the side of the recess which is subject to loads when torque is transmitted, the roller assembly is supported against said tilting moment by supporting faces radially outwardly of the roller assembly relative to the joint axis whilst in the side of the recess not subject to loads when torque is transmitted the roller assembly is supported on faces which are disposed radially inwardly of the roller assembly.

4. A joint according to Claim 2 or Claim 3 wherein, when the roller assembly is not tilted by said moment, there is a space between elements of the roller assembly and supporting faces in the recess.

5. A joint according to Claim 3 or Claim 4 wherein the supporting faces in the recesses are constituted by the tracks themselves, which in cross-section through the joint, are of different cross-sectional shape from the outer surfaces of the rollers.

6. A joint according to Claim 1 wherein the resultant of forces acting on the roller through the first mentioned surfaces is at a perpendicular distance from the axis of rotation of the joint greater than the perpendicular distance from the axis of rotation of the joint of the resultant of forces acting on the roller from the outer joint member, so that the roller is subject to a tilting moment outwardly about its contact with the loaded track.

7. A joint according to Claim 6 wherein the outer joint member and roller assembly have supporting faces arranged so that in the recess side subject to loads when torque is being transmitted the roller assembly is supported against said tilting movement by supporting faces radially inwardly of the roller assembly relative to the joint axis whilst in the recess side not subjected to loads the roller

assembly is supported on supporting faces radially outwardly of the roller assembly faces.

8. A joint according to Claim 7 wherein when torque is not being transmitted there is a free space radially of the joint between the supporting faces and the roller assembly.

9. A joint according to any one of Claims 6 to 8 wherein the supporting faces of the parts of the roller assembly which, under the influence of the tilting moment on the roller come into contact with the recess, have a smaller diameter relative to the arm axis than the surfaces of the roller contacting the track.

10. A joint according to any one of the preceding Claims wherein each arm of the inner joint member has a cylindrical surface on which is guided an inner ring with an internal cylindrical surface so as to be movable lengthwise of the arm thereon, said inner ring having a part-spherical outer surface engaging an at least partly part-spherical surface of a roller carrier held on the inner ring so as to be pivotable thereon, the roller being rotatably held on the roller carrier.

11. A joint according to Claim 6 wherein a needle roller bearing assembly is provided between the roller carrier and roller.

12. A joint according to any one of Claims 1 to 9 wherein each arm of the inner joint member comprises a part-spherical head on which is held a roller carrier with a cylindrical internal surface so as to be movable lengthwise of the arm and pivotable relative thereto, the roller being rotatably held on the roller carrier.

13. A joint according to Claim 12 wherein a needle roller bearing assembly is arranged between the roller carrier and roller.

14. A joint according to any one of Claims 1 to 9 wherein each arm of the inner joint member has a cylindrical surface on which is rotatably held an internally cylindrical inner ring having an external part-spherical surface engaging an internal cylindrical surface of the roller, so that the roller is displaceable lengthwise of the arm relative to the inner ring and pivotable thereabout.

15. A joint according to Claim 14 wherein a needle roller bearing assembly is disposed between the arm and the inner ring.

16. A joint substantially as hereinbefore described with reference to any one of the accompanying drawings.

17. Any novel feature or novel combination of features described herein and/or in the accompanying drawings.

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E miner's report to the Comptroller under Section 17 (The Search Report)

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(ii) Int Cl (Edition 5) F16D

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Databases (see over)

(i) UK Patent Office

(ii)

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Documents considered relevant following a search in respect of claims 1-16

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
Y	GB 2188701 A (NTN) see Figure 6, asymmetic points P	1
Y	GB 2070195 A (HONDA) see Figures 6 to 8; slidable, pivotable, rollers	1
Y	US 4741723 (ORAIN) see column 4, lines 9 to 21	1

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Category	Identity of document and relevant passages	Relevant to claim(s,

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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